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Hashimoto

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(54) **GAS TURBINE**

(75) Inventor: **Shinya Hashimoto**, Tokyo (JP)

(73) Assignee: **MITSUBISHI HITACHI POWER SYSTEMS, LTD.**, Yokohama-shi, Kanagawa (JP)

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F01D 11/04	(2006.01)
F01D 25/18	(2006.01)
F01D 9/06	(2006.01)

(52) **U.S. Cl.**

CPC ***F01D 11/001*** (2013.01); ***F01D 9/065*** (2013.01); ***F01D 11/04*** (2013.01); ***F01D 25/183*** (2013.01)

(58) **Field of Classification Search**

CPC F01D 5/085; F01D 5/087; F01D 9/065; F01D 25/12; F01D 25/125

See application file for complete search history.

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Primary Examiner — Nathaniel Wiehe
Assistant Examiner — Cameron Corday
(74) *Attorney, Agent, or Firm* — Westerman, Hattori, Daniels & Adrian, LLP

(57) **ABSTRACT**

A gas turbine includes: a cooling air pipe disposed at a downstream side of a rotor main body without contacting with the rotor main body and configured to feed cooling air into a cooling air main passage of the rotor main body; a bearing downstream end shaft seal annularly disposed at an outer circumferential side of the rotor main body and at a downstream side of a bearing which rotatably supports the rotor main body; and a collecting flow passage member having a leaked air collecting flow passage that guides the cooling air, which is leaked from the bearing downstream end shaft seal to the bearing side, into an exhaust flow passage through which a combustion gas passing through a final blade stage flows.

4 Claims, 4 Drawing Sheets

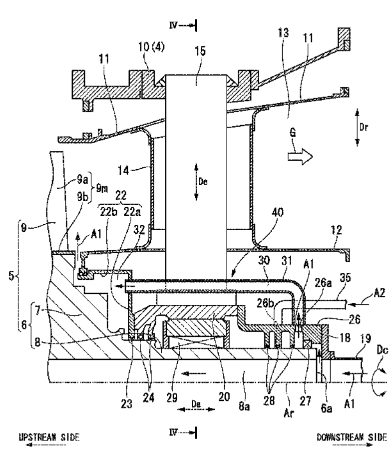

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FIG. 1

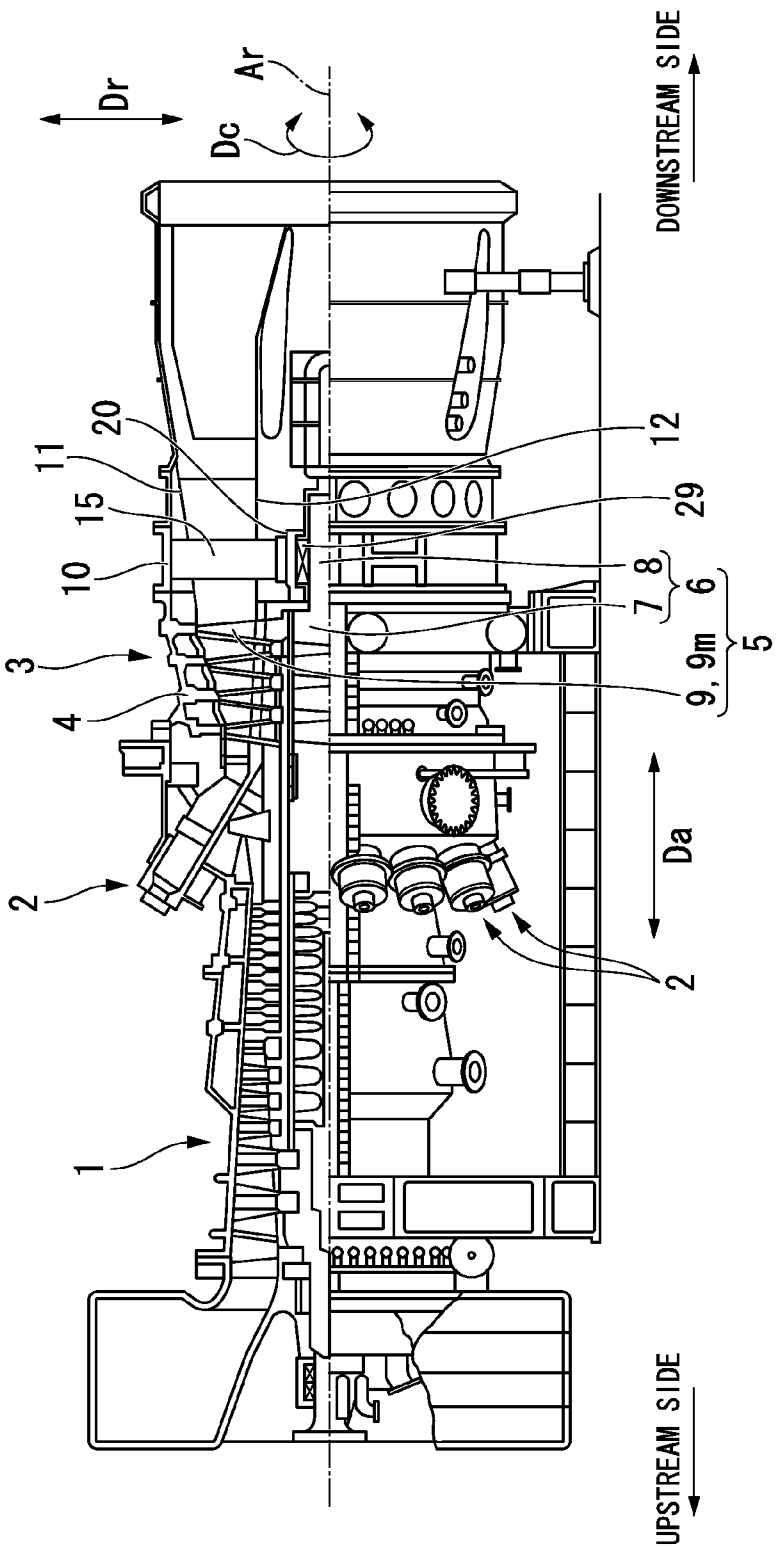
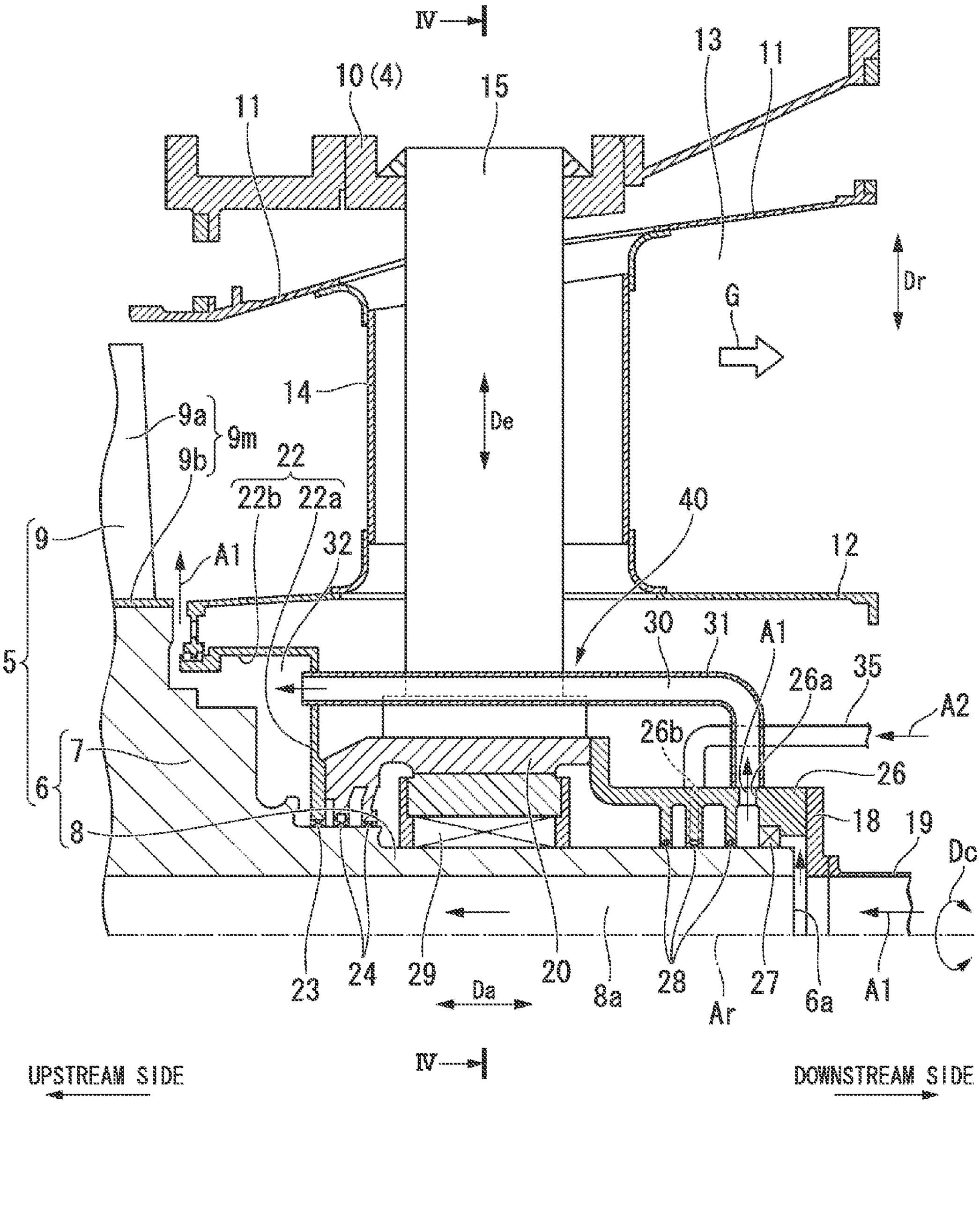

DOWNSTREAM SIDE
UPSTREAM SIDE
Dr
Ar
Dc
Da
1
2
3
4
5
6
7
8
9, 9m
10
11
12
15
20
29

FIG. 2


IV
IV
10 (4)
15
13
11
11
Dr
G
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De
9a
9m
9b
22
22b
22a
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A1
32
40
12
5
30
31
A1
26a
35
A2
7
6
26b
26
8
18
19
Dc
23
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20
8a
28
27
6a
A1
Ar
Da
UPSTREAM SIDE
DOWNSTREAM SIDE

FIG. 3

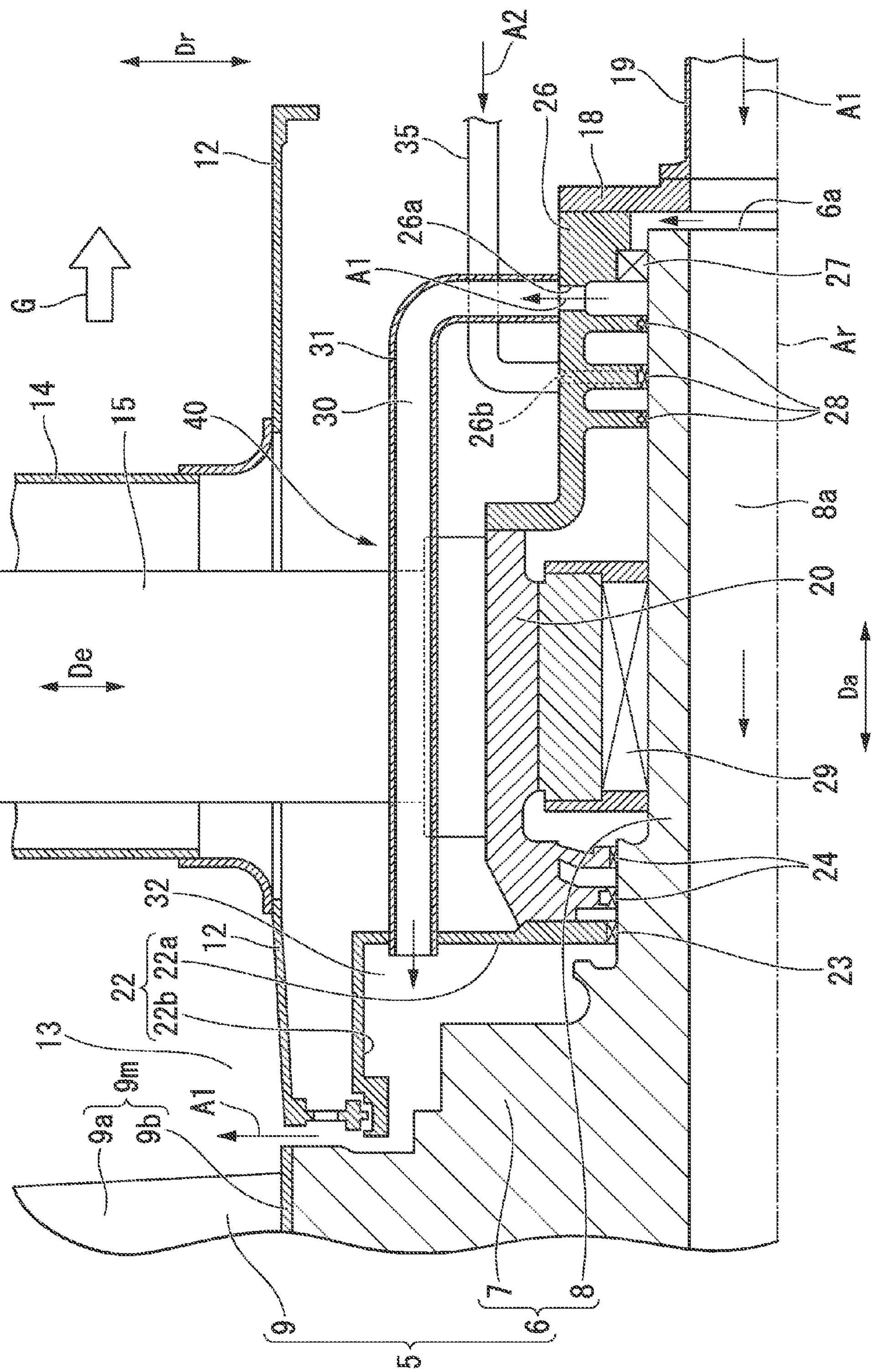
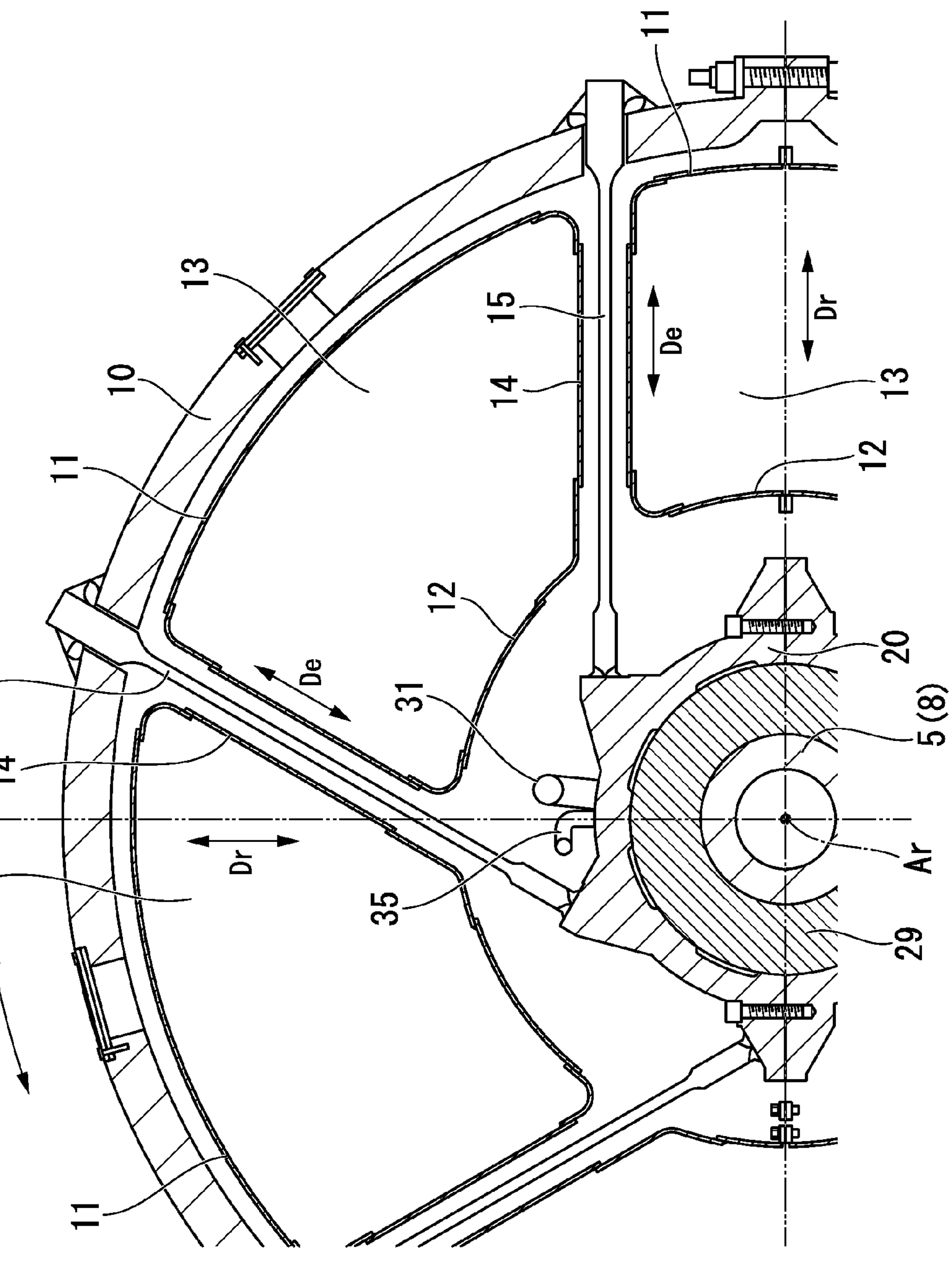

Dr
A2
A1
G
12
35
26
19
18
14
15
40
31
30
26a
26b
6a
27
28
Ar
8a
20
De
Da
29
24
23
32
22
22a
22b
13
9m
9a
9b
7
8
9
6
5

FIG. 4



GAS TURBINE

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a gas turbine, and more particularly, to a structure around a bearing of a gas turbine.

This application claims priority to and the benefit of Japanese Patent Application No. 2012-037720 filed on Feb. 23, 2012, the disclosures of which are incorporated by reference herein.

2. Description of the Related Art

A gas turbine includes a compressor, a combustor, and a turbine. The compressor compresses external air to generate compressed air. The combustor mixes a fuel with the compressed air to combust them, generating a combustion gas. The turbine has a rotor rotated by the combustion gas. The rotor generally has a rotor main body and a plurality of blade stages. The rotor main body extends in an axial direction parallel to the rotation axis. The plurality of blade stages is fixed to an outer circumference of the rotor main body to be arranged in the axial direction.

In the above-mentioned gas turbine, with increasing efficiency, a temperature of the combustion gas supplied to the turbine is increased to an extremely high temperature. For this reason, most components of the turbine are parts to be cooled, and a final blade stage of the rotor is also a part to be cooled.

A gas turbine in which a final blade stage is cooled, for example, is disclosed in the following Patent Document 1. A cooling air main passage opened at a downstream end of the rotor main body and extending in the axial direction is formed at the rotor main body of the gas turbine, and a blade cooling air passage configured to introduce cooling air supplied through the cooling air main passage into the final blade stage is formed at the rotor main body. A cooling air pipe not in contact with the rotor main body is disposed at a downstream side of the rotor main body. Compressed air extracted from the compressor via the cooling air pipe is supplied into the cooling air main passage of the rotor main body as cooling air. That is, in the gas turbine, as the compressed air extracted from the compressor is fed to the final blade stage via the cooling air pipe and the rotor main body as the cooling air, the final blade stage is cooled.

Here, in the gas turbine, a downstream side seal retaining ring configured to cover an outer circumferential side of the rotor main body is installed at a downstream side of a bearing configured to rotatably support the rotor main body, and a shaft seal is installed at an inner circumferential side of the downstream side seal retaining ring.

A temperature of the compressed air extracted from the compressor is raised by adiabatic compression in the compressor. The compressed air has a sufficiently low temperature to cool a blade but a relatively high temperature for the bearing of the rotor. For this reason, when the bearing of the rotor is exposed to the compressed air, the bearing may be heated, which causes trouble. Here, in the gas turbine, the shaft seal is disposed at the downstream side of the bearing, and a portion of the compressed air extracted from the compressor is prevented from flowing to the bearing side through a gap between the rotor main body and the cooling air pipe.

RELATED ART DOCUMENT

Patent Document

[Patent Document 1] PCT Application Laid-open No. 2010/001655

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

In the technique disclosed in Patent Document 1, as described above, the shaft seal is disposed to prevent a portion of the compressed air extracted from the compressor from flowing to the bearing side. However, in the technique disclosed in Patent Document 1, the bearing is heated by the compressed air leaked from the shaft seal to the bearing side, and trouble may occur with the bearing.

Here, in order to solve the problems, it is an object of the present invention to provide a gas turbine capable of preventing the bearing of the rotor from being heated.

Means for Solving the Problems

In order to accomplish the object, the present invention provides a gas turbine including a rotor rotated around a rotation axis by a combustion gas, and a bearing rotatably supporting a portion of a downstream side of the rotor, wherein the rotor has a rotor main body extending in an axial direction parallel to the rotation axis of the rotor, and a plurality of blade stages fixed to an outer circumference of the rotor main body and arranged in the axial direction, and a cooling air main passage opened at a downstream end of the rotor main body and extending in the axial direction is formed at the rotor main body, and the gas turbine includes: a cooling air pipe disposed at a downstream side of the rotor main body without contacting with the rotor main body and configured to feed cooling air into the cooling air main passage of the rotor main body; a bearing downstream end shaft seal annularly disposed at the outside of the rotor main body in a radial direction and at the downstream side of the bearing; and a collecting flow passage member having a leaked air collecting flow passage that guides the cooling air, which reaches to the bearing downstream end shaft seal from a clearance between the downstream end of the rotor main body and the cooling air pipe via the outside of the rotor main body in the radial direction and is leaked from the bearing downstream end shaft seal to the bearing side, into an exhaust flow passage through which the combustion gas passing through a final blade stage among the plurality of blade stages flows.

In the gas turbine according to the present invention, compressed air extracted from a compressor of the gas turbine is supplied into the cooling air pipe as the cooling air. The cooling air passes through the cooling air main passage of the rotor main body from the cooling air pipe to be guided to, for example, a blade, and the cooling air cools the blade.

In the gas turbine according to the present invention, since the rotating rotor is not in contact with the cooling air pipe, which does not rotate, a portion of the cooling air supplied from the cooling air pipe into the cooling air main passage of the rotor main body enters the outer circumferential side of the rotor main body from the downstream end of the rotor main body. The compressed air extracted from the compressor as the cooling air has a sufficiently low temperature to cool the blade but a relatively high temperature for the bearing of the rotor. For this reason, when the bearing is exposed to the cooling air, the bearing is heated and it causes trouble in the bearing.

Accordingly, in the gas turbine according to the present invention, as the bearing downstream end shaft seal is installed at a downstream side of the bearing, the cooling air entering the outer circumferential side of the rotor main body is prevented from flowing to the bearing side. However, similar to the bearing downstream end shaft seal, a seal leakage occurs between a rotating body and a stationary body due to imperfect sealing therebetween. For this reason, in the gas turbine according to the present invention, a portion of the cooling air is leaked from the bearing downstream end shaft seal to the bearing side.

Here, in the gas turbine according to the present invention, the leaked air collecting flow passage is formed, and leaked cooling air, which is a portion of the cooling air leaked from the bearing downstream end shaft seal to the bearing side is guided into the exhaust flow passage through which the combustion gas passing through the final blade stage flows. For this reason, in the gas turbine according to the present invention, it is possible to prevent the bearing from being heated by the compressed air extracted from the compressor as the cooling air.

Here, the gas turbine may include an outer diffuser disposed at a downstream side of the final blade stage and having a tubular shape around the rotation axis; and an inner diffuser having a tubular shape around the rotation axis and disposed at the inside of the outer diffuser in a radial direction and the outside of the rotor main body in a radial direction, so that the exhaust flow passage is formed between the outer diffuser and the inner diffuser, wherein the leaked air collecting flow passage guides the leaked cooling air from the inside in the radial direction of the inner diffuser into the exhaust flow passage.

In the gas turbine according to the present invention, the leaked air collecting flow passage can be reduced in length, rather than discharging the leaked cooling air from the outside in the radial direction of the outer diffuser into the exhaust flow passage. For this reason, in the gas turbine according to the present invention, equipment cost can be suppressed. Further, in the gas turbine according to the present invention, as the leaked air collecting flow passage is reduced in length, pressure loss of the cooling air passing through the flow passage is reduced. For this reason, even when the pressure of the compressed air extracted from the compressor as the cooling air is not increased, the cooling air leaked from the bearing downstream end shaft seal can be collected.

In addition, in the gas turbine, the leaked air collecting flow passage may guide the leaked cooling air to an upstream side of the inner diffuser.

In the gas turbine, pressure (static pressure) at a position of the upstream side of the inner diffuser, which is the downstream side of the final blade stage in the exhaust flow passage, i.e., an inlet section of the exhaust flow passage, is a slightly negative pressure. In the gas turbine according to the present invention, the cooling air leaked from the bearing downstream end shaft seal to the bearing side is discharged into the inlet section of the exhaust flow passage. For this reason, in the gas turbine according to the present invention, in order to collect the cooling air leaked from the bearing downstream end shaft seal to the bearing side, even when the pressure of the compressed air extracted from the compressor as the cooling air is not increased, the leaked cooling air can be collected.

In addition, the gas turbine may include a downstream side seal retaining ring having a tubular shape around the rotation axis, configured to cover a portion of the rotor main body at a downstream side of the bearing, and provided with the bearing downstream end shaft seal at the inside thereof in the radial direction; and a bearing-side downstream side shaft seal disposed at the inside of the downstream side seal retaining ring in the radial direction, the downstream side of the bearing, and the upstream side of the bearing downstream end shaft seal, wherein a through-hole, which penetrates through the downstream side seal retaining ring from the inside thereof in the radial direction to the outside thereof in the radial direction, is formed at a position between the bearing downstream end shaft seal and the bearing-side downstream side shaft seal in the axial direction, and the through-hole forms a portion of the leaked air collecting flow passage. In this case, the collecting flow passage member may have a leaked air collecting pipe in which a flow passage in communication with the through-hole of the downstream side seal retaining ring is formed.

In the gas turbine according to the present invention, the bearing-side downstream side shaft seal is installed at a downstream side of the bearing and an upstream side of the bearing downstream end shaft seal, and the cooling air leaked from the bearing downstream end shaft seal flows into the leaked air collecting flow passage at the downstream side of the bearing-side downstream side shaft seal. For this reason, it is possible to substantially perfectly prevent the leaked cooling air from flowing into the bearing.

Effect of the Invention

According to the present invention, it is possible to prevent the bearing from being heated by the compressed air extracted from the compressor as the cooling air.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cut-out side view of major parts of a gas turbine according to an embodiment of the present invention.

FIG. **2** is a cross-sectional view of the major parts of the gas turbine according to the embodiment of the present invention.

FIG. **3** is an enlarged view around a bearing of FIG. **2**.

FIG. **4** is a cross-sectional view taken along line IV-IV of FIG. **2**.

MODES FOR CARRYING OUT THE INVENTION

Hereinafter, an embodiment of a gas turbine according to the present invention will be described in detail with reference to FIGS. **1** to **4**.

As shown in FIG. **1**, the gas turbine of the embodiment includes a compressor **1**, a plurality of combustors **2**, and a turbine **3**. The compressor **1** compresses external air to generate compressed air. The plurality of combustors **2** mixes fuel from a fuel supply source with the compressed air to combust them, generating a combustion gas. The turbine **3** is driven by the combustion gas.

The turbine **3** includes a casing **4**, and a turbine rotor **5** rotated in the casing **4**. For example, the turbine rotor **5** is connected to a generator (not shown) configured to generate power by rotation of the turbine rotor **5**. The plurality of combustors **2** is fixed to the casing **4** at regular intervals to each other in a circumferential direction Dc around a rotation axis Ar of the turbine rotor **5**. In addition, as will be described below, a direction parallel to the rotation axis Ar is simply referred to as an axial direction Da, and a radial direction with respect to the rotation axis Ar is simply referred to as a radial direction Dr. In addition, in the axial direction Da, the compressor **1** side with respect to the turbine **3** is referred to as an upstream side and the turbine **3** side with respect to the compressor **1** is referred to as a downstream side.

The turbine rotor **5** includes a rotor main body **6**, and a plurality of blade stages **9**. The rotor main body **6** extends around the rotation axis Ar in the axial direction Da. The plurality of blade stages **9** is fixed to an outer circumference of the rotor main body **6** to be arranged in the axial direction Da. The rotor main body **6** has a plurality of rotor discs **7**, and a shaft section **8**. The plurality of rotor discs **7** is arranged in the axial direction Da to be connected to each other. The shaft section **8** is fixed to the rotor disc **7** of the most downstream side and extends in the axial direction Da. One of the blade stages **9** is fixed to an outer circumference of one of the rotor discs **7**. The blade stage **9** includes a plurality of blades **9***m* fixed side by side in a circumferential direction of the rotor disc **7**. The blade **9***m* includes a blade main body **9***a*, a platform **9***b*, and a blade root. As shown in FIG. **2**, the blade main body **9***a* extends in the radial direction Dr. The platform **9***b* is formed at an inner end in a radial direction of the blade main body **9***a*. The blade root (not shown) extends from the platform **9***b* inward in the radial direction. The blade root of the blade **9***m* is inserted into the rotor disc **7** to be fixed to the rotor disc **7**. The shaft section **8** has a columnar shape around the rotation axis Ar, and is formed at a downstream side of the rotor disc **7** of the final stage.

The casing **4** has an exhaust chamber wall **10** having a cylindrical shape around the rotation axis Ar and disposed at a downstream side of the blade **9***m* of the final stage. An outer diffuser **11** and an inner diffuser **12** having a cylindrical shape around the rotation axis Ar are disposed at the inside of the exhaust chamber wall **10** in the radial direction. The outer diffuser **11** is installed along an inner circumferential surface of the exhaust chamber wall **10**. The inner diffuser **12** is disposed at the inside of the outer diffuser **11** in the radial direction to be spaced apart therefrom. An exhaust flow passage **13** of a combustion gas G used to rotate the turbine rotor **5** is formed between the outer diffuser **11** and the inner diffuser **12**.

A bearing **29** and a bearing box **20** are installed inside of the inner diffuser **12** in the radial direction. The bearing **29** rotatably supports the shaft section **8** of the turbine rotor **5**. The bearing box **20** covers an outer circumferential side of the bearing **29** and supports the bearing **29**. An upstream side seal retaining ring **22** is fixed to an upstream end of the bearing box **20**, and a downstream side seal retaining ring **26** is fixed to a downstream end of the bearing box **20**.

The exhaust chamber wall **10** and the bearing box **20** are connected by a strut **15** passing through the outer diffuser **11** and the inner diffuser **12**. As shown in FIGS. **2** and **4**, the strut **15** extends in a tangential direction of the turbine rotor **5** and is covered by a strut cover **14** in an extension direction De thereof. One end in the extension direction De of the strut cover **14** is provided with the outer diffuser **11**, and the other end thereof is provided with the inner diffuser **12**.

As shown in FIG. **3**, a cooling air main passage **8***a* extending in the axial direction Da is formed at the rotor main body **6**. The cooling air main passage **8***a* is opened at a downstream end of the rotor main body **6**. A rotor sealing flange **18** spaced apart from the rotor main body **6** in the axial direction Da is disposed at a downstream end **6***a* of the rotor main body **6**. The rotor sealing flange **18** is fixed to the downstream side seal retaining ring **26** at an outer circumferential side portion thereof. A cooling air pipe **19** is fixed to the rotor sealing flange **18**. The cooling air pipe **19** is in communication with the cooling air main passage **8***a* of the turbine rotor **5**.

The upstream side seal retaining ring **22** includes a seal holding section **22***a*, and a space partition section **22***b*. The seal holding section **22***a* having a disc shape around the rotation axis Ar is configured to be directed outward in the radial direction from the shaft section **8** of the turbine rotor **5** with a bearing upstream end shaft seal **23** interposed therebetween. The space partition section **22***b* having a cylindrical shape around the rotation axis Ar extends from an outer end of the seal holding section **22***a* in the radial direction toward an upstream side. The space partition section **22***b* having the cylindrical shape is disposed to have a space from the outer

circumferential surface of the rotor main body **6** to the outside thereof in the radial direction, and is disposed to have a space from the inner circumferential surface of the inner diffuser **12** to the inside thereof in the radial direction. In addition, the upstream end of the space partition section **22***b* is disposed to have a space in the axial direction Da from the rotor disc **7** of the final stage. The bearing upstream end shaft seal **23** is installed inside of the seal holding section **22***a* of the upstream side seal retaining ring **22** in the radial direction. In addition, a plurality of bearing-side upstream side shaft seals **24** is installed inside of the upstream end of the bearing box **20** in the radial direction.

A space between the seal holding section **22***a* of the upstream side seal retaining ring **22** and the axial direction Da of the rotor disc **7** of the final stage and between the space partition section **22***b* of the upstream side seal retaining ring **22** and the outer circumferential side of the rotor main body **6** in the radial direction Dr is a leaked air discharge flow passage **32**. The leaked air discharge flow passage **32** is connected with the exhaust flow passage **13** via a space between the downstream end of the platform **9***b* of the blade **9***m* of the final stage and the upstream end of the inner diffuser **12**.

A plurality of bearing-side downstream side shaft seals **28** and a plurality of bearing downstream end shaft seals **27** are installed inside of the downstream side seal retaining ring **26** in the radial direction. The plurality of bearing-side downstream side shaft seals **28** is disposed at the bearing **29** side, that is, the upstream side of the bearing downstream end shaft seals **27**. A first through-hole **26***a* passing from the inside in the radial direction to the outside in the radial direction is formed at the downstream side seal retaining ring **26** at a position in the axial direction Da between the plurality of bearing-side downstream side shaft seals **28** and the bearing downstream end shaft seals **27**. In addition, a second through-hole **26***b* passing from the inside in the radial direction to the outside in the radial direction is formed at the downstream side seal retaining ring **26** at a position in the axial direction Da between the bearing-side downstream side shaft seal **28** of the most upstream side and the bearing-side downstream side shaft seal **28** of the most downstream side among the plurality of bearing-side downstream side shaft seals **28**.

A first end of a leaked air collecting pipe **31** is connected to a position of the first through-hole **26***a* of the downstream side seal retaining ring **26**. A second end of the leaked air collecting pipe **31** is connected to the seal holding section **22***a* of the upstream side seal retaining ring **22**. The leaked air collecting pipe **31** is a pipe forming a flow passage configured to bring a flow passage in the first through-hole **26***a* of the downstream side seal retaining ring **26** in communication with the leaked air discharge flow passage **32**. In the embodiment, a leaked air collecting flow passage **30** is formed by the flow passage in the first through-hole **26***a* of the downstream side seal retaining ring **26**, a flow passage in the leaked air collecting pipe **31**, and the leaked air discharge flow passage **32**. Accordingly, a collecting flow passage member **40** configured to form the leaked air collecting flow passage **30** is constituted by the downstream side seal retaining ring **26** having the first through-hole **26***a*, the leaked air collecting pipe **31**, and the turbine rotor **5** and the upstream side seal retaining ring **22** forming the leaked air discharge flow passage **32**.

A first end of a shaft seal air pipe **35** is connected to a position of the second through-hole **26***b* of the downstream side seal retaining ring **26**. A second end of the shaft seal air pipe **35** is connected to a shaft seal air supply source which is not shown.

Next, various air flows in the gas turbine as described above will be described with reference to FIG. **2**.

For example, compressed air of several kg/cm^2 extracted from the compressor **1** at about 200° C. is supplied into the cooling air pipe **19** disposed at the downstream side of the turbine rotor **5** as cooling air **A1**. The cooling air **A1** flows into the cooling air main passage **8***a* of the rotating turbine rotor **5**, and further, cools the blade **9***m* and so on via a blade cooling air passage. In addition, shaft seal air **A2** having a temperature and a pressure lower than the cooling air **A1** extracted from the compressor **1** is supplied from a shaft seal air supply source to the shaft seal air pipe **35**. The shaft seal air **A2** is supplied from the second through-hole **26***b* of the downstream side seal retaining ring **26** to a position between an inner circumferential side of the downstream side seal retaining ring **26** and an outer circumferential side of the shaft section **8** of the turbine rotor **5** and between the bearing-side downstream side shaft seal **28** of the most upstream side and the bearing-side downstream side shaft seal **28** of the most downstream side. In addition, the shaft seal air **A2** is used as sealing air between an inner circumferential side of the downstream side seal retaining ring **26** and an outer circumferential side of the shaft section **8** of the turbine rotor **5**.

The cooling air pipe **19**, the rotor sealing flange **18** to which the cooling air pipe **19** is fixed, and the downstream side seal retaining ring **26** fixed to the rotor sealing flange **18**, which are not rotated, are not in contact with the rotating turbine rotor **5**. For this reason, a portion of the cooling air **A1** supplied into the cooling air main passage **8***a* of the turbine rotor **5** from the cooling air pipe **19** enters the outer circumferential side of the shaft section **8** from the downstream end of the shaft section **8** of the turbine rotor **5**. The cooling air **A1** has a sufficiently low temperature to cool the blade **9***m*, but a relatively high temperature for the bearing **29** of the turbine rotor **5**. For this reason, when the bearing **29** of the turbine rotor **5** is exposed to the cooling air **A1**, the bearing **29** is heated, and for example, a trouble is caused such that oil in the bearing **29** is carbonized or the like.

Accordingly, in the embodiment, as the bearing downstream end shaft seals **27** are installed, the cooling air **A1** entering the outer circumferential side of the shaft section **8** of the turbine rotor **5** is prevented from flowing to the bearing **29** side. However, as in the bearing downstream end shaft seals **27**, a seal leakage occurs between the rotating body (the turbine rotor **5**) and a stationary body due to imperfect sealing therebetween. For this reason, even in the embodiment, a portion of the cooling air **A1** is leaked from the bearing downstream end shaft seals **27** to the bearing **29** side. When the cooling air **A1** leaked from the bearing downstream end shaft seals **27** is simply discharged to the outside of the downstream side seal retaining ring **26** in the radial direction, the bearing **29** is heated by the cooling air **A1** via the bearing box **20**.

Here, in the embodiment, the leaked air collecting flow passage **30** connects the space, which is between the plurality of bearing-side downstream side shaft seals **28** and the bearing downstream end shaft seals **27**, and the exhaust flow passage **13**. The cooling air **A1** leaked from the bearing downstream end shaft seals **27** to the bearing **29** side is discharged to the exhaust flow passage **13** through the leaked air collecting flow passage **30**, the bearing box **20** and the bearing **29** are prevented from being heated by the leaked cooling air **A1**.

However, a pressure (a static pressure) at a position of the upstream side of the inner diffuser **12**, which is the downstream side of the blade **9***m* of the final stage in the exhaust flow passage **13**, i.e., an inlet section of the exhaust flow passage **13**, is a slightly negative pressure. In the embodiment, the cooling air **A1** leaked from the bearing downstream end shaft seals **27** to the bearing **29** side is discharged to the inlet section of the exhaust flow passage **13**. For this reason, in the embodiment, in order to collect the cooling air **A1** leaked from the bearing downstream end shaft seals **27** to the bearing **29** side, even when the pressure of the compressed air extracted from the compressor **1** as the cooling air **A1** is not increased, since the pressure (the static pressure) of the inlet section of the exhaust flow passage **13** is a slightly negative pressure, the leaked cooling air **A1** can be collected.

In addition, in the embodiment, since the cooling air **A1** leaked from the bearing downstream end shaft seals **27** to the bearing **29** side is discharged into the exhaust flow passage **13** from the inside of the inner diffuser **12** in the radial direction, the leaked air collecting flow passage **30** can be reduced in length rather than the flow passage discharging the cooling air into the exhaust flow passage **13** from the outside of the outer diffuser **11** in the radial direction. For this reason, the leaked air collecting pipe **31** configured to form a portion of the leaked air collecting flow passage **30** can be reduced in length, and equipment cost can be suppressed. Further, as the leaked air collecting flow passage **30** is reduced in length, the pressure loss of the cooling air **A1** passing through the flow passage **30** is reduced. For this reason, even when the pressure of the compressed air extracted from the compressor **1** as the cooling air **A1** is not increased, the cooling air **A1** leaked from the bearing downstream end shaft seals **27** can be collected.

In addition, while only one leaked air collecting pipe **31** and only one shaft seal air pipe **35** are shown in FIG. **4**, a plurality of leaked air collecting pipes **31** and a plurality of shaft seal air pipes **35** may be installed in the circumferential direction.

INDUSTRIAL APPLICABILITY

In the present invention, it is possible to prevent the bearing from being heated by the compressed air extracted from the compressor as the cooling air.

DESCRIPTION OF REFERENCE NUMERALS

1 compressor
2 combustor
3 turbine
4 casing
5 turbine rotor
6 rotor main body
7 rotor disc
8 shaft section
8*a* cooling air main passage
9 blade stage
9*m* blade
10 exhaust chamber wall
11 outer diffuser
12 inner diffuser
13 exhaust flow passage
14 strut cover
15 strut
19 cooling air pipe
20 bearing box
22 upstream side seal retaining ring
23 bearing upstream end shaft seal
24 bearing-side upstream side shaft seal
26 downstream side seal retaining ring
26*a* first through-hole
26*b* second through-hole
27 bearing downstream end shaft seal
28 bearing-side downstream side shaft seal
29 bearing

30 leaked air collecting flow passage
31 leaked air collecting pipe
32 leaked air discharge flow passage
35 shaft seal air pipe
40 collecting flow passage member

What is claimed is:

1. A gas turbine including a rotor rotated around a rotation axis by a combustion gas, a bearing rotatably supporting a portion of a downstream side of the rotor, and a bearing box covering an outer circumferential side of the bearing and supporting the bearing, the gas turbine comprising:

a rotor main body provided in the rotor and extending in an axial direction parallel to the rotation axis around the rotation axis;

a plurality of blade stages provided in the rotor and fixed to an outer circumference of the rotor main body and arranged in the axial direction;

a cooling air main passage opened at a downstream end of the rotor main body and extending in the axial direction formed at the rotor main body;

a cooling air pipe disposed at a downstream side of the rotor main body without contacting with the rotor main body and configured to feed cooling air into the cooling air main passage of the rotor main body;

a downstream side seal retaining ring fixed to the bearing box and configured to cover a portion of the rotor main body at a downstream side of the bearing;

a bearing downstream end shaft seal annularly disposed at the outside of the rotor main body in a radial direction and at the downstream side of the bearing, and installed inside of the downstream side seal retaining ring in the radial direction;

a bearing-side downstream side shaft seal disposed at the downstream side of the bearing and the upstream side of the bearing downstream end shaft seal, and installed inside of the downstream side seal retaining ring in the radial direction; and

a collecting flow passage member having a leaked air collecting flow passage that guides the cooling air, which reaches to the bearing downstream end shaft seal from a clearance between the downstream end of the rotor main body and the cooling air pipe via the outside of the rotor main body in the radial direction and is leaked from the bearing downstream end shaft seal to the bearing side, into an exhaust flow passage through which the combustion gas passing through the blade stage flows,

wherein the downstream side seal retaining ring includes:

a first through-hole that is disposed at a position between the bearing downstream end shaft seal and the bearing-side downstream side shaft seal in the axial direction, and that penetrates through the downstream side seal retaining ring from the inside thereof in the radial direction to the outside thereof in the radial direction; and

a second through-hole that is disposed at a position between the farthest downstream side of the bearing-side downstream side shaft seal and a downstream side of the bearing, and that penetrates through the downstream side seal retaining ring from the inside thereof in the radial direction to the outside thereof in the radial direction, and

wherein a portion of the collecting flow passage member is connected to the first through-hole, and

a shaft seal air pipe that supplies a shaft seal air from a shaft seal air supply source to the inside of the downstream side seal retaining ring in the radial direction is connected to the second through-hole.

2. The gas turbine according to claim **1**, comprising:

an outer diffuser disposed at a downstream side of the final blade stage disposed at the farthest downstream side among the plurality of the blade stages and having a tubular shape around the rotation axis; and

an inner diffuser having a tubular shape around the rotation axis and disposed at the inside of the outer diffuser in a radial direction and the outside of the rotor main body in a radial direction, so that the exhaust flow passage is formed between the outer diffuser and the inner diffuser,

wherein the leaked air collecting flow passage guides the leaked cooling air from the inside in the radial direction of the inner diffuser into the exhaust flow passage.

3. The gas turbine according to claim **2**, wherein the leaked air collecting flow passage guides the leaked cooling air to an upstream side of the inner diffuser.

4. The gas turbine according to claim **1**, wherein the collecting flow passage member has a leaked air collecting pipe in which a flow passage in communication with the first through-hole of the downstream side seal retaining ring is formed.

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